

9-34 PAVEMENT MARKING MATERIAL

9-34.1 General

Pavement marking materials in this section consist of paint, plastic, tape or raised pavement markers as described in Section 8-22 and 8-23 as listed below:

- High VOC Solvent Based Paint
- Low VOC Solvent Based Paint
- Low VOC Waterborne Paint
- Temporary Pavement Marking Paint
- Type A – Liquid Hot Applied Thermoplastic
- Type B – Pre-formed Fused Thermoplastic
- Type C – Cold Applied Pre-formed Tape
- Type D – Liquid Cold Applied Methyl Methacrylate
- Glass Beads
- Temporary Pavement Marking Tape
- Temporary Raised Pavement Markings

9-34.2 Paint

White and yellow paint shall comply with the Specifications for high volatile organic compound (VOC) solvent based paint, low VOC solvent based paint or low VOC waterborne paint. Blue paint for “Access Parking Space Symbol with Background” shall be chosen from a WSDOT QPL listed Manufacturer. The blue color shall match Fed Standard 595, color 15090 and the tolerance of variation shall match that shown in the FHWA “Highway Blue Color Tolerance Chart.”

9-34.2(1) High VOC Solvent Based Paint

High VOC solvent based paint material requirements are as follows:

Abrasion Resistance – ASTM D 968

125 liters minimum of falling sand on a 3 mil dry film thickness.

Accelerated Settling – ASTM D 869, modified as follows:

Paint shall be placed in a motor driven machine that raises and lowers a sample tray providing a shock to the sample which accelerates pigment settling. The samples shall be placed in the machine for one week, 24 hours per day, at a temperature of 77 degrees F. The samples shall show no more than 0.25-inch of clear material over the opaque portion of the paint and there shall be no settling below a rating of eight.

Bleeding over asphalt – ASTM D 969, modified as follows:

The reflectance measurement of the paint over asphalt paper shall be at least 90% of the reflectance measurement of the paint over a taped (non-bleeding) surface.

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a, color number 33538 and the tolerance of color variation shall match that shown in the FHWA “Highway Yellow Color Tolerance Chart (PR Color #1)”

Contrast Ratio at 5 mils wet film thickness – ASTM D 2805

White-92% minimum

Yellow-88% minimum

Daylight Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 86% with a green filter on a 10 mil wet film thickness

Density – ASTM D 1475, at 70 degrees F

White – 12.00 pounds/gallon minimum

Yellow – 12.10 pounds/gallon minimum

Fineness of Dispersion – ASTM D 1210

2 minimum (Hegman Scale)

Flexibility – ASTM D 522

The paint shall be applied at a wet film thickness of 5 mils to a 3x5-inch tin panel that has been solvent cleaned and lightly buffed with steel wool. With the panel kept in a horizontal position, the paint shall be allowed to dry for 18 hours at 75 +/- 5 degrees F then baked for 3 hours at 212 +/- 4 degrees F. The panel shall be cooled to 75 +/- 5 degrees F for at least 30 minutes, bent over a 0.5-inch mandrel and then examined without magnification. The paint shall show no cracking, flaking or loss of adhesion.

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 10 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface, shall “dry to no-pick-up” in 35 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 10 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The “dry to no-pick-up” tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 35 seconds after the test line is applied to the pavement. A successful test will be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Nonvolatile Content – ASTM D 2369

65%-68%

Pigment Specifications

Medium Chrome Yellow (yellow paint) – ASTM D 211 Type III

Titanium Dioxide (white paint) – ASTM D 476 Type II, III, or IV

The inert or filler pigments shall be first quality paint grade products.

Pigment Content – ASTM D 2371

53% maximum

Re-dissolve

A 15 mil wet film thickness of paint shall be applied to a glass panel. The paint shall be air dried for 16 hours at 77 degrees F then baked for 4 hours at 140 degrees F. The panel shall be cooled to room temperature and placed in a quart container that is half filled with the same paint being tested. The container shall be sealed and left undisturbed for 18 hours. After removing the panel from the container, a wooden spatula shall be drawn lightly over the painted surface. The immersed portion of the paint film shall be completely dissolved with no evidence of dried paint remaining on the panel.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Settling – ASTM D 869

The test shall be run for a period of six months. There shall be no settling below a rating of eight.

Storage Stability

Samples shall show no settling as received by the Materials laboratory and only slight soft settling after the sample has aged undisturbed for one month. No hard caking in the bottom of the container shall be permitted. The paint shall not show evidence of heavy caking or settling which requires mechanical means to return the product to usable condition for a period of one year from the date of manufacture. There shall be no viscosity increase in excess of 10 Krebs Units over the originally reported viscosity after aging in the container for six months, and there shall be no evidence of corrosion of the container or decomposition of the product. Field examination of previously un-opened containers shall not disclose evidence of undissolvable gelatinous vehicle separation, heavy skin formation or corrosion of the container on samples in storage one year or less.

Vehicle Composition

The vehicle may be any combination of natural or synthetic resinous materials, except those that dry by the process of oxidation and/or polymerization (such as alkyd resins which are specifically excluded). All resins used must be permanently capable of re-dissolving in the solvent combination used in the paint.

Viscosity – ASTM D 562

86 Krebs units maximum at 50 degrees F

70-75 Krebs units at 70 degrees F

66 Krebs units minimum at 122 degrees F

9-34.2(2) Low VOC Solvent Based Paint

Low VOC solvent based paint material requirements are as follows:

Bleeding over asphalt – ASTM D 969, modified as follows:

The reflectance measurement of the paint over asphalt paper shall be at least 90% of the reflectance measurement of the paint over a taped (non-bleeding) surface.

Chromium Content – ASTM D 3718

< 50 ppm

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a color number 33538 and the tolerance of color variation shall match that shown in the FHWA “Highway Yellow Color Tolerance Chart (PR Color #1)”.

Directional Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 80%.

Density – ASTM D 1475, at 70 degrees F

11.8 pounds/gallon minimum

Flexibility – ASTM D 522

The paint shall be applied at a wet film thickness of 6 mils to a 3x5-inch panel that has been solvent cleaned and lightly buffed with steel wool. With the panel kept in a horizontal position, the paint shall be allowed to dry for 18 hours at 75 +/- 5 degrees F then baked for 3 hours at 140 +/- 4 degrees F. The panel shall be cooled to 75 +/- 5 degrees F for at least 30 minutes, bent over a 0.25-inch mandrel and then examined without magnification. The paint shall show no cracking, flaking or loss of adhesion.

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 15 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface shall “dry to no-pick-up” in 90 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 15 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The “dry to no-pick-up” tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 90 seconds after the test line is applied to the pavement. A successful test shall be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Lead Content – ASTM D 3335

0.06% maximum

Nonvolatile Content – ASTM D 2369

65% minimum

Package Stability – ASTM D 1849

6 rating minimum for all criteria

Pigment Content – ASTM D 2371

53% maximum

Re-dissolve

A 15 mil wet film thickness of paint shall be applied to a glass panel. The paint shall be air dried for 16 hours at 77 degrees F then baked for 4 hours at 140 degrees F. The panel shall be cooled to room temperature and placed in a quart container that is half filled with the same paint being tested. The container shall be sealed and left undisturbed for 18 hours. After removing the panel from the container, a wooden spatula shall be drawn lightly over the painted surface. The immersed portion of the paint film shall be completely dissolved with no evidence of dried paint remaining on the panel.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skinning

The paint shall not skin within 48 hours in a ¾ filled tightly closed container.

Settling Properties during Storage – ASTM D 1309

The sample shall show no more than 0.5-inch of clear material over the opaque portion of the paint and there shall be no settling below a rating of seven.

Titanium Dioxide (Rutile Type II) ASTM D 476

White – 1.0 pounds per gallon minimum. (ASTM D 4563)

Yellow – 0.2 pounds per gallon maximum. (ASTM D 4563)

Viscosity – ASTM D 562

105 Krebs units maximum at 50 degrees F

75-85 Krebs units at 70 degrees F

65 Krebs units minimum at 120 degrees F

Volatile Organic Compound Content – ASTM D 3960

1.25 pounds per gallon maximum

9-34.2(3) Low VOC Waterborne Paint

Low VOC waterborne paint material requirements are as follows:

Binder – ASTM D 3168

The binder shall be 100% acrylic.

Chromium Content – ASTM D 3718

<50 ppm

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a color number 33538 and the tolerance of color variation shall match that shown in the FHWA “Highway Yellow Color Tolerance Chart (PR Color #1)”

Contrast Ratio at 15 mils wet film thickness – ASTM D 2805

White – 98% minimum

Yellow – 96% minimum

Directional Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 88% on a 15 mil wet film thickness

Fineness of Dispersion – ASTM D 1210

3 minimum (Hegman Scale)

Flash Point – ASTM D 93

100 degrees F minimum

Freeze Thaw – ASTM D 2243

5 cycles minimum

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 15 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface shall “dry to no-pick-up” in 90 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 15 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The “dry to no-pick-up” tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 90 seconds after the test line is applied to the pavement. A successful test shall be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Lead Content – ASTM D 3335

0.06% maximum

Nonvolatile Content – ASTM D 2369

60% minimum

Nonvolatile Vehicle – ASTM D 2369, ASTM D 3723

Nonvolatile vehicle is calculated from the Nonvolatile content as determined in ASTM D2369 and the Pigment content as determined in ASTM D 3723.

$\% \text{Nonvolatile vehicle} = 100 - (100 - \% \text{Nonvolatile content}) - \% \text{Pigment}$

Shall be 36% minimum by weight.

pH – ASTM E 70

9.5 minimum

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Scrub Resistance – ASTM D 2486

500 cycles minimum

Static Heat Stability

A one pint lined container shall be filled with approximately 15 fluid ounces of paint. The container shall be sealed with tape and put in an oven maintained at 135 +/-1 degrees F for seven days. The paint shall be removed from the oven and equilibrated at standard conditions (ASTM D 3924). The paint shall be mixed thoroughly with gentle stirring. The viscosity shall be determined. The paint shall show no increase in viscosity greater than 10 Krebs units over the viscosity at 77 degrees F (see Viscosity below) nor shall the paint show any coagulation, lumps or coarse particles.

Viscosity – ASTM D 562

100 Krebs units maximum at 77 degrees F

Volatile Organic Compound Content – ASTM D 3960

1.25 pounds per gallon maximum

9-34.2(4) Temporary Pavement Marking Paint

Paint used for temporary pavement marking shall conform to the requirements of Section 9-34.2 and shall be applied in one application at a thickness of 15 mils or 107 square feet per gallon.

9-34.3 Plastic

White and yellow plastic pavement marking materials shall comply with the Specifications for:

- Type A – Liquid hot applied thermoplastic
- Type B – Pre-formed fused thermoplastic
- Type C – Cold applied pre-formed tape
- Type D – Liquid cold applied methyl methacrylate

Blue plastic pavement marking material for “Access Parking Space Symbol with Background” shall be chosen from a WSDOT QPL listed Manufacturer. The blue color shall match Fed Standard 595, color 15090 and the tolerance of variation shall match that shown in the FHWA “Highway Blue Color Tolerance Chart.”

9-34.3(1) Type A – Liquid Hot Applied Thermoplastic

Type A material consists of a mixture of pigment, fillers, resins and glass beads that is applied to the pavement in the molten state by extrusion or by spraying. The material can be applied at a continuously uniform thickness or it can be applied with a profiled pattern. Glass beads, intermixed and top dress, shall conform to the manufacturer’s recommendations necessary to meet the retroreflectance requirements. Type A material shall conform to the requirements of AASHTO M 249 and the following:

Resin – The resin shall be alkyd or hydrocarbon.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

9-34.3(2) Type B – Pre-formed Fused Thermoplastic

Type B material consists of a mixture of pigment, fillers, resins and glass beads that is factory produced in sheet form. The material is applied by heating the pavement and top heating the material. The material shall contain intermixed glass beads. The material shall conform to AASHTO M 249, with the exception of the relevant differences for the materials being applied in the pre-formed state and the following:

Resin – The resin shall be alkyd or hydrocarbon.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

9-34.3(3) Type C – Cold Applied Pre-formed Tape

Type C material consists of plastic pre-formed tape that is applied cold to the pavement. The tape shall be capable of adhering to new and existing hot mix asphalt or cement concrete pavement. If the tape manufacturer recommends the use of a surface primer or adhesive, use a type approved by the pavement marking manufacturer. The tape shall also be capable of being inlaid into fresh hot mix asphalt during the final rolling process. The material is identified by the following designations: Type C-1 tape has a surface pattern with retroreflective elements exposed on the raised areas and faces and intermixed within its body and shall conform to ASTM D 4505, Reflectivity Level I, Class 2 or 3, Skid Resistance Level A. Type C-2 tape has retroreflective elements exposed on its surface and intermixed within its body and shall conform to the requirements of ASTM D 4505, Reflectivity Level II, Class 2 or 3, Skid Resistance Level A, and the following:

Retroreflectance – ASTM D 6359 modified as follows: (units are millicandelas/meter²/lux)

Reflectivity Level I

White – 500 measured with a 30-meter instrument

Yellow – 300 measured with a 30-meter instrument

Reflectivity Level II

White – 250 measured with a 30-meter instrument

Yellow – 175 measured with a 30-meter instrument

9-34.3(4) Type D – Liquid Cold Applied Methyl Methacrylate

Type D material consists of a two part mixture of methyl methacrylate and a catalyst that is applied cold to the pavement. The material can be applied at a continuously uniform thickness or it can be applied with profiles (bumps). The material is classified by Type designation, depending upon the method of application. Type D-1 material is be applied by hand operated extrusion device, pouring or hand troweling. Type D-2 and D-5 material shall be applied by spraying. Type D-3 and D-4 material shall be applied by machine extrusion. Glass beads, intermixed and top dress, shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type D-1, D-2, D-3, and D-4 material shall have intermixed glass beads in the material prior to application. Type D-5 material shall have glass beads injected in to the material at application and a second coating of top dressing beads applied immediately after material application. Type D material shall conform to the following:

Adhesion

Asphalt substrate – substrate failure

Portland Cement Concrete substrate – 200 psi.

Chemical Resistance

The material shall show no effect after seven day immersion in anti-freeze, motor oil, diesel fuel, gasoline, calcium chloride, sodium chloride or transmission fluid.

Composition

Type D-1 – One gallon of methyl methacrylate and 3 fluid ounces of benzoyl peroxide powder.

Type D-2, D-3, D-4, and D-5 – Four parts methyl methacrylate and one part liquid benzoyl peroxide.

Elongation – ASTM D 638

20% minimum

Hardness – ASTM D 2240 (Shore Durometer Type D)

55 minimum after 24 hours

No Track Time – ASTM D 711, modified as follows:

15 minutes at 40 mils.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

Tensile Strength – ASTM D 638

125 psi minimum at break

Viscosity – ASTM D 2196 Method B, LV Model at 50 rpm.

Type D-1 – 11,000 to 15,000 cps, spindle #7

Type D-2 – 26,000 to 28,000 cps, spindle #7

Type D-3 – 17,000 to 21,000 cps, spindle #7

Type D-4 – 8,000 to 10,000 cps, spindle #4

Type D-5 White – 5,000 to 8,000 cps, spindle #4

Type D-5 Yellow – 7,000 to 11,000 cps, spindle #4

Ultraviolet Light

No effect

9-34.4 Glass Beads

Glass beads for traffic paint shall conform to AASHTO M 247 and the following:

Gradation - AASHTO M 247 Type 1

Coating - The glass beads shall be coated with a silicone for moisture resistance and a silane to promote adhesion in both waterborne and solvent base traffic paint. The presence of the coating is to be verified by WSDOT test method T430.

Chemical Make-up and Environmental Protection - Glass beads shall not contain any element in excess of the following established total concentration limits when tested in accordance with the listed test methodology.

Concentration Limits.

Element	Test Method	Max. parts per million (ppm)
Arsenic	*EPA SW846 6010B	20.0 ppm
Barium	*EPA SW846 6010B	100.0 ppm
Cadmium	*EPA SW846 6010B	1.0 ppm
Chromium	*EPA SW846 6010B	5.0 ppm
Lead	*EPA SW846 6010B	50.0 ppm
Selenium	*EPA SW846 6010B	1.0 ppm
Silver	*EPA SW846 6010B	5.0 ppm
Mercury	**EPA SW846 7471A	0.2 ppm

Test Method: * EPA's SW846 6010B, inductively coupled plasma-atomic emissions spectrometry (ICP-AES). Reference Concentration Limits.

**EPA's Method SW846 7471A, cold-vapor absorption method. Reference Concentration Limits.

9-34.5 Temporary Pavement Marking Tape

Temporary pavement marking tape shall be pressure sensitive, reflective type, conforming to ASTM D 4592, designed for application on asphalt or concrete pavement. Biodegradable tape with paper backing shall not be allowed. Surface preparation and application shall be in conformance with all the manufacturer's recommendations. Pavement marking masking tape shall conform to ASTM D 4592 Type 1 (removable), except that material shall be black, non-retroreflective and non-glaring.

9-34.6 Temporary Raised Pavement Markers

Temporary flexible raised pavement markers shall consist of an L-shaped body with retroreflective tape on the top of one face for one-way traffic and reflective tape on the top of both faces for two-way traffic. The marker body shall be made from 0.060-inch minimum thick polyurethane. The top of the vertical leg shall be between 1.75 and 2.0-inches high and shall be approximately 4-inches wide. The base width shall be approximately 1.125-inches wide. The base shall have a pressure sensitive adhesive material, a minimum of 0.125-inch thick with release paper. The reflective tape shall be a minimum of 0.25-inch high by 4.0-inches wide. The reflective tape shall have a minimum reflectance of 3.5 candlepower per foot-candle for white and 2.5 candlepower per foot-candle for yellow measured at 0.2° observation angle and 0° entrance angle. When temporary flexible raised pavement markers are used for bituminous surface treatment operations, the markers shall be supplied with a protective cover made of clear polyvinyl chloride. The cover shall be removed after spraying asphaltic material.

Temporary raised pavement markers other than temporary flexible raised pavement markers shall conform to the requirements of Section 8-09.2.

9-34.7 Field Testing

Field testing is required for all pavement marking materials. The material shall be applied in the field by the manufacturer and shall be monitored to determine durability and appearance characteristics. At the Department's discretion, field performance data gained from independent testing may be submitted in lieu of field testing. Acceptance of independent testing shall be the prerogative of the State Material Laboratory.